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SURVIVAL AND REPRODUCTION OF WILD TURKEY HENS IN CENTRAL ONTARIO

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ABSTRACT.—Recent success of Eastern Wild Turkey (*Meleagris gallopavo silvestris*) reintroductions across southern Ontario has prompted wildlife managers to investigate the potential of extending the northern limit of this subspecies' range. We monitored the survival and reproduction of introduced Wild Turkeys on the Precambrian Shield in central Ontario during 1999–2001. Mean annual survival of 39 radio-tagged hens was 0.288 ± 0.057 SE. Summer and winter survival rates differed between the first and second years of the study. Spring and fall survival rates did not differ significantly between years. Reproductive parameters that characterized the population included a nesting rate of 0.588, mean clutch size of 10.0 eggs/nest, nest success of 0.500, hatching rate of 0.81, hen natality rate of 1.18 females hatched/female, poult survival of 0.54, and fall recruitment of 0.63 juvenile females/breeding hen. Success of the pilot Wild Turkey introduction in central Ontario was compromised by high predation, low numbers of introduced birds, and a prolonged period of deep snow during 2000–2001. *Received 14 November 2002, accepted 10 March 2003.*

The Eastern Wild Turkey (*Meleagris gallopavo silvestris*) was native to southwestern Ontario (Wintemberg 1919), but disappeared by 1907 due to unregulated hunting and habitat loss (Alison 1976). Reintroduction from various state Dept. of Natural Resources was initiated in 1984 (Weaver 1989), resulting in about 30,000 birds in the southern part of the province by 2000 (Bellamy 2001). The success of recent reintroduction efforts in southern Ontario, potentially favorable habitat alterations in central Ontario during the past century, and recent moderate winters prompted wildlife managers to consider pilot Wild Turkey introductions into presumably marginal northern habitats. Although the promiscuous breeding and high reproductive rate of Wild Turkeys (i.e., early breeders with large clutches) promote the species' likelihood to be successfully translocated (Griffith et al. 1989), small populations at the fringe of their geographic range incur a greater risk of extinction if either (1) predation rates are high, (2) Wild Turkeys are exposed to severe weather for prolonged periods of time, (3) food shortages force Wild Turkeys into unfavorable ranges, (4) number of other prey species is low, (5) current Wild Turkey populations are low, or (6) nesting cover is poor (Miller and Leopold 1992).

Wild Turkey populations are dynamic, which limits our understanding of the demographic parameters responsible for successful introduction into suboptimal habitats (Little and Varland 1981, Clark 1985, Miller et al. 1985, Weaver 1989). One potential factor responsible for changes in abundance at northern latitudes is winter mortality, where survival varies from 40% during severe conditions in forested landscapes to 93% during mild conditions in mixed agricultural and forested environments (Austin and DeGraff 1975, Wunz and Hayden 1975, Porter et al. 1980, Vander Haegen et al. 1988, Roberts et al. 1995). However, severe winters are sporadic, and associated mortality typically is a minor limitation on Wild Turkey abundance (Roberts et al. 1995). Nest success and poult survival are other factors limiting annual population change through reproduction (Vangilder et al. 1987, Roberts et al. 1995). Nest success typically varies between 31 and 62% (Porter et al. 1983, Vangilder et al. 1987, Vander Haegen et al. 1988, Roberts et al. 1995), and poult mortality within 2 weeks after hatching often varies between 60 and 92% (Little and Varland 1981, Speake et al. 1985, Vangilder et al. 1987, Vander Haegen et al. 1988).

There exists little, if any, survival and reproduction information on female Wild Turkeys inhabiting the Precambrian Shield, north

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of the species' historic range in central Ontario. It may be inappropriate to apply management strategies from published accounts of more southern Wild Turkey populations due to their annual fluctuations. Our objectives were to estimate survival and reproduction rates of newly introduced Eastern Wild Turkey hens in central Ontario, and to determine the relative importance of demographic parameters to annual population change. We hypothesized that (1) predator-induced mortality was greatest during nesting and brood rearing, and that (2) winter mortality in mixed agricultural and forested landscapes was not a limiting factor to annual population growth.

METHODS

Study area.—We conducted this study near Noëlville, located 60 km southeast of Sudbury (46° 10′ N, 80° 25′ W), Ontario, Canada. The 169-km^2 study area, delineated from movements of female radio-tagged Wild Turkeys, was located in the Great Lakes-St. Lawrence Ecotonal Forest Region (Rowe 1972), and characterized by flat to rolling topography (mean elevation of 210 m), interrupted by rock outcrops and narrow valleys. The landscape contains a mosaic of habitat, comprising approximately 20% coniferous forests, 37% deciduous forests, 16% agricultural land, 12% grass and meadow, and 15% residential areas and rock outcrops in parts of Bigwood, Cosby, Martland, Mason, and Scollard townships. Beef farming is the dominant industry, with most fields cultivated for corn silage or pasture grasses.

Fire, logging, and smelter emissions from Sudbury's mining operations destroyed or reduced much of the original climax vegetation, which included balsam fir (*Abies balsamea*), eastern white and red pine (*Pinus strobus*, *P. resinosa*), red oak (*Quercus rubra*), white spruce (*Picea glauca*), red and sugar maple (*Acer rubrum*, *A. saccharum*), and eastern hemlock (*Tsuga canadensis*; Rowe 1972). The resulting forests are dominated by white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*), with raspberry (*Rubus* spp.), bracken fern (*Pteridium aquilinum*), blueberry (*Vaccinium* spp.), beaked hazel (*Corylus cornuta*), and aster (*Aster* spp.) in the understory.

We obtained meteorological data (21 March 1999 to 20 March 2001) from Environment Canada, Sudbury. January was the coldest month of the year (mean temperature was −12.2° C), whereas July was the warmest month (mean temperature was 18.9° C). Mean annual rainfall was 73.9 cm from 21 March 1999 to 20 March 2000 and 51.1 cm from 21 March 2000 to 20 March 2001. Snowfall was 216.0 cm from November 1999 to March 2000 and 328.3 cm from November 2000 to March 2001, with snow depths exceeding 25 cm for 38 days from November 1999 to March 2000 and 111 days from November 2000 to March 2001.

Wild Turkey capture.—We captured 36 Eastern Wild Turkeys (10 males and 26 females), in southern Ontario and upper New York State, which were introduced during February and March 1999. Thirteen more hens from New York State were released in March 2000. All birds were captured with rocket nets (Hawkins et al. 1968), sexed, aged (Pelham and Dickson 1992), marked with patagial wing tags, and transported to the study area. We radio-tagged females with a backpack style 32.5-g mortality-mode VHF radio transmitter (Holohil Systems Ltd., Carp, Ontario). Transmitters represented about 1% of turkey body mass and were attached with 3.2-mm shock cord (Norman et al. 1997). The expected battery life was 150 weeks. We excluded from analyses birds that died within 14 days of release to reduce bias associated with capture-related stress and transmitter harness complications (Nenno and Healy 1979).

Survival.—We monitored instrumented female Wild Turkeys 5 days/week between 1 May and 31 August and 2–3 days/week between 1 September and 30 April and from 21 March 1999 to 20 March 2001. We obtained telemetry locations by triangulation from ≥3 locations (Heezen and Tester 1967) taken <15 min apart, with a 2-element H antenna and portable receiver-scanner (Model STR-1000, Lotek Engineering Inc., Newmarket, Ontario). We calculated seasonal survival rates for four time intervals: calendar spring, summer, fall, and winter. We recovered transmitters on mortality mode within 1–2 days to determine cause of mortality by examining the carcass and area surrounding the recovery site. When date of death was unknown, we assumed death to have occurred midway between the previous and current monitoring dates.

We used the staggered entry design of the Kaplan-Meier method to determine survival rates ($\hat{S}$) and distributions (Pollock et al. 1989). We selected this method because newly instrumented Wild Turkeys were introduced into our study area during four separate releases, and it allowed for birds to be censored due to emigration or radio loss. We readmitted female Wild Turkeys that survived the year into the following year's data set (Roberts et al. 1995). We also estimated crude annual and seasonal survival rates, with predation as the only source of mortality, using the Kaplan-Meier approach by censoring all deaths not resulting from this agent (Kurzejeski et al. 1987). Mortality rates are not independent, and other mortality agents can influence this estimate (Heisey and Fuller 1985). Calculation of survival standard errors followed the method of Cox and Oakes (in Pollock et al. 1989). We used the log-rank test to determine annual differences in survival distribution. We used the *Z*-test statistic to examine differences in annual and seasonal survival rates.

Reproduction.—We determined nest locations by close range radio telemetry and triangulation. We flagged vegetation about 15 m around each nest site to prevent intrusions and nest abandonment by females. When telemetry indicated nest abandonment due to fledging, depredation, or other disturbances, we located the nest at the center of the flagged area. We excluded birds from the data set if research activities disrupted nesting (i.e., if hens did not return to their nests), except for information obtained prior to the disruption, such as nest site characteristics and clutch size. We defined nesting rate as the proportion of radio-tagged females that nested by 1 May, and renesting rate as the proportion of females that renested after an unsuccessful first attempt. The first date of incubation (five or more days of localized movements or inactivity) was used to determine nest initiation date and hatching date by subtracting 10 days for egg laying and adding 28 days for incubation (Healy 1992).

We defined nests as successful if one or more eggs hatched. We estimated clutch size by examination of eggshells and unhatched eggs. Because nest predators may remove some eggs, we considered this estimate as the minimum clutch size (Thogmartin and Johnson 1999). We determined the type of nest predation from predator tracks and eggshell breakage patterns (Cooper and Ginnett 2000). We assumed that the number of hatched eggs was equal to the initial brood size, and we defined hatching rate as the proportion of eggs that hatched in each clutch. Hen success was the probability that a nesting hen hatched one or more egg, regardless of the number of nesting attempts (Vangilder 1992). We calculated age specific female natality rates (m_x) as:

$$m_x = [(nr_x)(c_x)(ns_x)(hr_x)]/2,$$

where nr_x = nesting rate of age x, c_x = clutch size, ns_x = nesting success, and hr_x = hatching rate (Porter et al. 1983). We based clutch size and hatching rate during the first year of our study on one case due to difficulties in locating nests. We used flush counts to estimate poult survival (p_x), measured as the number of poults alive on 1 October, relative to the number hatched by all successful females. Despite the potential for brood adoption by co-occurring adult females, we assumed poults shared the same fate as maternal females that died before a flush count was conducted. We based first year poult survival on the number of poults alive in early fall relative to the number observed 14–28 days after hatching. We estimated recruitment of young females (R) into the fall population as the number of female poults/successful maternal female surviving to early fall (Porter et al. 1983):

$$R = (m_x)(p_x).$$

We used the log-likelihood ratio (Sokal and Rohlf 1995), median test (Sokal and Rohlf 1995), and Mann Whitney *U*-test to examine differences in reproductive parameters based on age and study year. The small 1999 sample size precluded comparison of clutch size between study years. We conducted statistical analyses with SPSS software (SPSS Institute, Inc. 1998).

RESULTS

Female survival rates.—Twenty-five of 26 and 12 of 13 radio-tagged Wild Turkey hens survived the 14-day adjustment periods during 1999–2000 and 2000–2001, respectively. We censored 15 hens due to signal loss because of transmitter failure or bird emigration from the study area. Mean annual survival probability was 0.529 during 1999–2000 and 0.067 during 2000–2001, for a mean of 0.288 during the two years (Table 1). Annual survival distributions ($\chi^2 = 6.78$, df = 1, $P = 0.009$) and survival rates ($Z = 4.22$, $P < 0.0001$) differed significantly between years. Spring and fall survival rates were similar between years ($Z = 1.03$, $P = 0.30$ and $Z = 0.66$, $P = 0.51$, respectively). Female survival rates during summer and winter were greater ($Z = 1.86$, $P = 0.063$ and $Z = 3.26$, $P = 0.001$) during 1999–2000 (0.701 ± 0.121 SE and 0.900 ± 0.069 SE, respectively) than during 2000–2001 (0.381 ± 0.122 SE and 0.222 ± 0.196 SE, respectively).

Annual survival rate, with predation as the only source of mortality, was significantly greater ($Z = 2.30$, $P = 0.021$) during 1999–2000 (0.631 ± 0.093 SE) than during 2000–2001 (0.187 ± 0.169 SE; Table 2). Thirteen of 22 females were killed by mammalian predators, which included red fox (*Vulpes vulpes*), coyote (*Canis latrans*), dog (*Canis familiaris*), and fisher (*Martes pennanti*). Avian predators, as judged from decapitation, killed three hens. Seasonal survival rates due to predation were similar between years ($Z = 0.00$–1.34, $P = 0.18$–1.00). Predator-related deaths occurred primarily during summer ($n = 8$), followed by spring ($n = 4$) and winter ($n = 4$). Remaining deaths were attributed to poaching ($n = 1$), starvation ($n = 1$), hay mowing ($n = 1$), and unknown causes ($n = 3$).

Reproductive effort.—Median date for first nest initiation in 1999 (3 June) was not statistically different than that in 2000 (17 May; $\chi^2 = 0.11$, df = 1, $P = 0.73$). These dates varied between 1999 (7 May to 10 June) and 2000 (1 May to 25 June). Median date for renest initiation during 2000 was 13 June (range: 22 May to 28 June). Median first nest initiation dates did not vary significantly ($\chi^2 = 0.02$, df = 1, $P = 0.88$) between nests of adult (18 May, range: 1 May to 25 June) and juvenile hens (21 May, range: 7 May to 15 June). Mean clutch size did not vary significantly with female age ($U = 6$, $P = 0.77$, power = 0.05; Table 3). We found seven clutches of ≤4 eggs, and excluded them from clutch size

TABLE 1. Annual and seasonal Kaplan-Meier survival rates ($\hat{S}$), with 95% confidence interval, for radio-tagged Eastern Wild Turkeys in central Ontario, 21 March 1999 to 20 March 2001. Annual survival distributions ($\chi^2 = 6.78$, df = 1, $P = 0.009$) and survival rates ($Z = 4.22$, $P < 0.0001$) differed between years. Summer ($Z = 1.86$, $P = 0.063$) and winter ($Z = 3.26$, $P = 0.001$) survival rates were greater during 1999–2000 than during 2000–2001. Spring ($Z = 1.03$, $P = 0.30$) and fall ($Z = 0.66$, $P = 0.51$) survival rates were similar between years.

	1999–2000				2000–2001				Pooled				
Period[a]	$\hat{S}$	95% CI	SE	Risk[b]	$\hat{S}$	95% CI	SE	Risk	$\hat{S}$	95% CI	SE	Risk	Z-score
Annual	0.529	0.356–0.702	0.088	17	0.067	0.000–0.195	0.065	1	0.288	0.176–0.400	0.057	18	4.22
Seasonal													
Spring	0.923	0.784–1.00	0.071	13	0.789	0.575–1.000	0.109	11	0.854	0.723–0.985	0.067	24	1.03
Summer	0.701	0.464–0.938	0.121	10	0.381	0.142–0.620	0.122	6	0.545	0.364–0.726	0.092	16	1.86
Fall	0.909	0.640–1.000	0.137	4	1.000	1.000–1.000	0.000	5	0.933	0.774–1.000	0.081	9	0.66
Winter	0.900	0.765–1.000	0.069	17	0.222	0.000–0.607	0.196	1	0.678	0.500–0.857	0.091	18	3.26

[a] Annual (21 March to 20 March), spring (21 March to 20 June), summer (21 June to 21 September), fall (22 September to 20 December), and winter (21 December to 20 March).
[b] Maximum number of female turkeys at risk of dying during the period.

TABLE 2. Crude annual and seasonal survival rates ($\hat{S}$), with predation as the only mortality source, of radio-tagged Eastern Wild Turkeys in Noëlville, Ontario, 21 March 1999 to 20 March 2001. Annual survival rate was greater during 1999–2000 than during 2000–2001 ($Z = 2.30$, $P = 0.021$). Seasonal survival rates did not differ significantly between years ($Z = 0.000–1.34$, $P = 0.18–1.00$).

Period[a]	1999–2000				2000–2001				Pooled				
	$\hat{S}$	95% CI	SE	Risk[b]	$\hat{S}$	95% CI	SE	Risk	$\hat{S}$	95% CI	SE	Risk	Z-score
Annual	0.631	0.449–0.813	0.093	17	0.187	0.000–0.519	0.169	1	0.416	0.269–0.563	0.075	18	2.30
Seasonal													
Spring	0.923	0.784–1.000	0.071	13	0.789	0.575–1.000	0.109	11	0.854	0.723–0.985	0.067	24	1.03
Summer	0.761	0.529–0.993	0.118	10	0.534	0.242–0.826	0.149	6	0.656	0.187–1.000	0.239	16	1.19
Fall	1.000	1.000–1.000	0.000	4	1.000	1.000–1.000	0.000	5	1.000	1.000–1.000	0.000	9	0.00
Winter	0.900	0.765–1.000	0.069	17	0.445	0.000–1.000	0.332	1	0.745	0.570–0.920	0.089	18	1.34

[a] Annual (21 March to 20 March), spring (21 March to 20 June), summer (21 June to 21 September), fall (22 September to 20 December), and winter (21 December to 20 March).
[b] Maximum number of female turkeys at risk of dying during the period.

analysis because they apparently had been depredated. Raccoons (*Procyon lotor*) presumably disturbed two of these clutches, based on tracks found near the nest. One nest was depredated by a red fox, indicated by teeth marks on eggshells, one by a Common Raven (*Corvus corax*; LPN pers. obs.), and three by unknown predators. Hatching rates did not differ significantly ($U = 3$, $P = 0.64$, power $= 0.05$) between adult (0.81 ± 0.05 SE) and juvenile females (0.80 ± 0.10 SE).

Nesting rate of adult females was not significantly different ($G = 1.29$, df $= 1$, $P = 0.26$, power $= 0.59$) than that of juvenile birds (0.682 and 0.417, respectively). Nesting rates also were not significantly different ($G = 1.79$, df $= 1$, $P = 0.18$, power $= 0.05$) between 1999 and 2000 (0.438 and 0.722, respectively). No differences in nest success were evident between age classes or years (all G values < 0.01, df $= 1$, $P = 1.00$). Natality rate in 1999 was 1.0 female hatched/female in the breeding population, whereas 1.3 females hatched/female in 2000. Adult hen natality was 1.3 females hatched/female in the breeding population, and 0.4 females hatched/female for juvenile hens. Poult survival of adult birds was 0.68, and 0.17 for juvenile hens. Fall recruitment was 0.63 juvenile females/breeding hen.

DISCUSSION

Our mean annual survival rate of hens was less than in populations introduced to Indiana (Miller et al. 1985), Iowa (Little and Varland 1981), and Ohio (Clark 1985). Different methodologies used to calculate survival rates and standard errors may, in part, explain our low survival rates. Disadvantages of their method to calculate mortality rates by dividing number of radio-tagged hens dead per month by the number alive at the beginning of the month are that survival is biased if censored observations are excluded from analysis, and that survival is assumed constant throughout each month (Kurzejeski et al. 1987). The Kaplan-Meier procedure does not have these disadvantages (Pollock et al. 1989). Annual survival during 1999–2000 was similar to those of established populations in northern Missouri (Kurzejeski et al. 1987) and southcentral New York (Roberts et al. 1995). Survival during 2000–2001 was the least reported for this

TABLE 3. Reproductive parameters of Eastern Wild Turkey hens in Noëville, Ontario, 1999–2000.

	Nesting rate (*n*)	Clutch size (*n*)	Nest success (*n*)	Hatching rate	Natality rate[a]	Poult survival[b]	Recruitment rate[c]
Year							
1999	0.438 (7)	9.0 (1)	0.571 (4)	0.89	1.00	0.68	0.68
2000	0.722 (13)	10.1 (8)	0.461 (6)	0.79	1.33	0.39	0.52
Age							
Adult	0.682 (15)	10.0 (7)	0.467 (7)	0.81	1.29	0.68	0.88
Juvenile	0.417 (5)	10.0 (2)	0.250 (3)	0.80	0.42	0.17	0.07
Total	0.588 (20)	10.0 (9)	0.500 (10)	0.81	1.18	0.54	0.63

[a] Number of females hatched/female in the breeding population.
[b] Proportion of poults surviving through summer.
[c] Number of young females recruited into the fall population per successful nesting hen.

subspecies, which was attributed to high summer and winter mortality (Table 1). We realize that small sample size may limit our conclusions to this study because findings may not accurately reflect actual population parameters.

We did not evaluate if hen survival was a function of nesting-related activities, but incidental observations suggest this possibility. High hen mortality during this period may be attributed to several factors, but are not limited to (1) an increase in predator populations (Weaver 1989), (2) exposure to abnormal weather conditions for prolonged periods of time (Vangilder et al. 1987, Roberts et al. 1995), (3) poor nesting cover (Bowman and Harris 1980, Clark 1985), (4) a behavioral response of hens to low body mass by foraging more frequently (Porter et al. 1983, Thogmartin and Johnson 1999), and (5) low availability of other prey species (Miller and Leopold 1992). Predation accounted for 58% of hen turkey mortality, with losses during summer being the greatest (Table 2). Our data indicated differences between years for annual predator-related mortality rates, but we could not link this observation to high predator populations or low prey abundance. Roberts et al. (1995) hypothesized that warm, wet weather during spring and summer may facilitate nest location by predators by enhancing olfactory cues. Although we observed greater hen mortality after prolonged periods of rain during the 2000 breeding period, we found no evidence to suggest that hen mortality was related to rainfall ($r_s = -0.20$, $P = 0.47$, power $= 0.004$). High mortality occurred during 1999 when mean precipitation was above the 30 year normal, whereas low mortality occurred the following year when mean precipitation was below normal (Nguyen 2001). Dry weather may affect spring phenology by reducing vertical nest cover to increase predator search efficiency (Bowman and Harris 1980, Rolley et al. 1998).

Fluctuations in winter survival between 1999–2000 (0.900) and 2000–2001 (0.222) likely were due to variation in winter severity (Austin and DeGraff 1975, Wunz and Hayden 1975, Porter et al. 1980, Vander Haegen et al. 1988). High survival during 1999–2000, characterized by favorable snow conditions and abundant food supply, was consistent with rates observed during mild winters in Massachusetts (0.930; Vander Haegen et al. 1988), Minnesota (0.850; Porter et al. 1983), and New York (0.873; Roberts et al. 1995). Severe winter conditions have been associated with reduced survival of turkey populations at northern latitudes: 0.450 in Minnesota (Porter et al. 1983), 0.370 in New York (Austin and DeGraff 1975), and 0.600 in Pennsylvania (Wunz and Hayden 1975). We found no differences in predator-related winter mortality between 1999–2000 and 2000–2001, probably due to our small sample of hens at risk during 2000–2001. Predation and starvation probably were the major sources of winter mortality during this period; however, we did not have information to test these hypotheses.

Although we detected no statistical difference in median nest initiation date between 1999 (3 June) and 2000 (17 May), this difference of two weeks may be biologically significant. Introduced hens surviving their first year may be familiar with local habitats, and thus reduce the time needed to locate suitable nest sites, as compared to inexperienced, newly introduced birds. Alternatively, capture-related stress may reduce energy reserves of newly introduced birds. The nutritional condition of hens may, in part, explain delays in nest initiation, foregoing of nesting, and clutch size (Thogmartin and Johnson 1999). Porter et al. (1983) suggested that a threshold body mass may exist; consequently, hens may delay nesting until nutrient reserves can be replenished.

Nest success in our study was greater than those reported in Arkansas (Thogmartin and Johnson 1999), Missouri (Vangilder et al. 1987) and New York (Roberts et al. 1995), but less than that reported in Minnesota (Porter et al. 1983). Mean nest success was similar to those reported in Virginia and West Virginia (Norman et al. 2001) and Massachusetts (Vander Haegen et al. 1988). Clutch size of 10.0 eggs found in our study was identical to those reported in northern Missouri (Vangilder et al. 1987), greater than the 8.8 eggs found in Arkansas (Thogmartin and Johnson 1999), but less than the 11.6 eggs reported in Iowa (Little and Varland 1981), 12.1 eggs in Massachusetts (Vander Haegen et al. 1988), 11.8 eggs in Minnesota (Porter et al. 1983), 12.0 eggs in New York (Roberts et al. 1995), 12.0 eggs in Ohio (Clark 1985), and 11.9 eggs in southern Ontario (Weaver 1989).

Natality rate in this study was less than those reported for adult and juvenile hens in Minnesota (Porter et al. 1983) and Massachusetts (Vander Haegen et al. 1988). Lower natality rates for adult and juvenile hens were reported for a population in decline in Arkansas (Thogmartin and Johnson 1999). The recruitment rate found in this study was similar to that reported in Massachusetts (Vander Haegen et al. 1988), but less than that reported in Minnesota (Porter et al. 1983). Failure to locate more than one nest in 1999 biased estimates of productivity, especially nesting rate and poult survival.

Our study indicates that a number of selective pressures (e.g., predation and weather) may have influenced Wild Turkey survival and reproduction. We cannot, however, discriminate among selection pressures without manipulation experiments. Although we suggested that predation and starvation may have been the major mortality factors in our study, they were not limiting factors. Many of the reproductive parameters we measured were comparable to those reported in southern Ontario (Weaver 1989), Minnesota (Porter et al. 1983), and Ohio (Clark 1985), where turkey populations have flourished. Currently, the population in our study area is estimated at 30–35 turkeys (K. Bellamy pers. comm.). This small population indicates that Wild Turkeys can survive and reproduce north of the species' historic range in Ontario.

Populations introduced in similar areas may not experience a rapid population growth as counterpart populations in southern Ontario (Weaver 1989, Bellamy 2001). In these areas, management for this species may require rigorous winter habitat improvement, such as planting shrubs that bear fruit late into the winter, to increase food availability above the snow. Since severe winters tend to occur approximately every fifth year in our region (Nguyen 2001), supplemental feeding may be necessary to maintain turkey numbers. However, this management strategy should be considered as a last resort because supplemental feeding can cause birds to aggregate, making them more susceptible to predation.

Wild Turkey introduction programs in similar areas (i.e., outside of their historic range) should take into consideration the habitat requirements of turkeys in the source population. For example, introducing birds to areas with different habitat structures may preclude those birds from recognizing the appropriate habitat features (Healy 1992, Badyaev 1995), which may lead to reduced survival and/or reproductive performance. In our study, we did not observe Wild Turkeys using manure piles for winter survival either because of unfamiliarity with potential food resources associated with manure and/or instinctive wariness of Wild Turkeys to approach areas with cattle. Introduction of birds to areas with different habitat structure is not well studied, and deserves further attention.

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